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Design of Adjustable Stair Climbing Walker

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Abstract

Over 41,000 elderly persons are thought to be injured by walkers every year. When a person's center of mass moves away from their base of support, they fall. The four legs of a walker define its footprint, which serves as the user's base of support when using one. Regrettably, a lot of people walk incorrectly with their feet outside the base of support when using walkers. This is an extremely risky posture that could lead to a fall. Lateral falls are the worst kind of falls because they can result in fatal hip fractures. We need to make the existing walkers better in order to lower lateral falls. As walker attachments, ways to adjust the user's center of mass and temporarily extend the base of support were devised. We compare the walker mechanisms with many companies and found out a mechanism which has high strength and quality. Ergonomics consideration also takes place in designing this device as it can be used with ease. It is easy to handle and light in weight. Push button at the handle is used to adjust the height very easily.

Keywords: Fall Prevention, Walker Design, Elderly Safety, Ergonomic Mobility Aid, Center of Mass Stability, Base of Support

I. INTRODUCTION

In 2021, there will be about 138 million senior citizens in India—67 million of them men and 71 million of them women. In comparison to the 2011 population census, there were approximately 34 million more old individuals in 2021. By 2031, it is projected that this number will increase by 56 million. Walkers are the preferred help for 1.8 million citizens and offer the most support. Crutches are used by 5,66,000 people, placing them in the center of the assistance spectrum.

People's muscles deteriorate and lose functionality as they age. This leads to a rise in falls, which are the leading cause of injuries among the senior population. These falls can cause injuries that impair motor function, independence, quality of life, and even cause death. Roughly 12% of senior citizens who lead active lives also utilize assistive devices to lower their risk of falling. Wheelchairs, scooters, crutches, walkers, and canes are some examples of these devices.

II. LITERATURE SURVEY

Stair Climbing Carts have been the subject of numerous patents. However, none took into account designing for clients with lower incomes or minimizing costs. The majority of the patents addressed aspects such as mechanism, structure, wheel design, and ease of weight carrying over stairs. The relevance of lowering these kinds of products' production costs has not received much attention from studies. Below is a discussion of a few literary works that are closely connected.

A stairway accessible cart with two foldable main wheels and two auxiliary wheels that were spring-loaded by two-way hinges was patented by Cheng, C. J.

Diener, H. received a patent for a cart with two sets of wheels: one set of larger wheels for navigating uneven terrain when the cart is laden, and another set of smaller wheels for moving the cart within buildings.

A stair-climbing apparatus with a reversible electric motor and load-bearing shoes pivotally attached was patented by R. Andruchiw. With arms that are pivotally coupled and a detecting head that detects thread touch, the gadget can move both forward and backward.

A hand-propelled cart with a detachable wheeled frame with a separate foldable portion to accommodate various sorts of items was patented by Carlile, E.A collapsible, folding cart with a frame that features first and second longitudinal frame members spaced apart to define a plane, two wheels, and a wheel axle attached to the frame was patented by Grace, J. For stair climbing, Hong, H. S., Seo, T., Kim, D., Kim, S., & Kim, J. created the ideal handcarrying rocker-bogie mechanism. A cart with three wheel assemblies on each side that rotate when the cart makes contact with stairs is patented by Wyrick, S. The cart can climb stairs. The wheelchair's design optimization was worked on by Zhang, L., and Xi, F. A stair climbing help system invented by Richard Danziger has two grips on opposite sides of the central axis, each of which is joined to the other by first and second connecting parts, which come together to form a handle frame.

III. REASON FOR A WALKER

Walkers are used to improve a person's walking stability and balance. The bulk of walkers' users are older since muscular mass declines with advancing age. Sarcopenia is the term

used to describe this phenomenon (Spirdus, Francis, & Mac Rae). Muscle strength declines with decreasing muscle mass, so that by the age of 60, it has already dropped by 20%, and by the age of 80, it has dropped by 40%. The sharp reduction in muscle mass has an impact on stability and balance. One's center of mass and velocity with respect to their base of support (BOS) determine their stability in both static and dynamic scenarios. A person's feet are their BOS. Because the BOS and COM are constantly changing in a dynamic setting, it is simpler to regulate the center of mass (COM) in a static scenario. Therefore, the person needs to have more muscle control in order to maintain balance when moving in a dynamic manner. Sarcopenia causes this process to become more difficult with age. The goal of walkers is to raise the BOS of elderly individuals, which enhances their stability and balance. By extending the BOS, the walker enables the user to maintain their communication within its bounds while moving over larger arcs of motion. The breadth and depth of a walker's legs in contact with the ground—also known as the walker's footprint—define its body surface area (BOS).

IV.WALKER RELATED CAUSES

Walkers can cause falls in part because they impede the user's natural reflexes to balance. When the walker isn't able to support the user sufficiently, they might have to utilize alternative strategies, such reaching for a railing or taking a step, to regain their equilibrium. A walker user's foot and leg are likely to collide with a horizontal bar or the walker's leg when they attempt a lateral step to regain their equilibrium. According to one study (Maki et al. 2008), 60% of the time a person using a walker took a lateral step to regain their balance, and their foot struck the walker in the process. The study was carried out on healthy young adults, but elderly persons with mobility impairments would be significantly less able to recover from a collision and not fall, even though they were unable to directly associate these collisions with an inability to recover one's balance.

A. Ergonomics Of Walker

Make sure your elbow is at a comfortable 15-degree angle and measure the height of your wrist. Stretch your arms out to the sides as you remain within the walker. The crease on the inside of our wrists should align with the top of the walker grip. Thus, a walker's height should be between 80 and 90 cm. A guy can lift 25 kg on average, while a woman can lift 16 kg on average. Therefore, a walker should weigh about 6 kg.

V. MECHANISMS

A. Pop Up Mechanism

Wheels, pull tabs, and flaps are some of the mechanisms that produce movement on the page surface. Pop-ups use a variety of folding methods to cause figures to stretch, unroll, rise, or pop up when a page is opened.

A pop-up mechanism for an extensible walker is improved and described. between order to work with a first elastic device and a fastening device, the popup mechanism consists of an extra elastic device between the sliding tube's overlaying section and the support tube. When the push button is manually depressed, the sliding tube that was locked by the button's pin unlocks and descends a predefined distance. This will let the hand that was previously pressing the push button to leave it unattended. Next, press the sliding tube down to its lowest locked position using the same hand. This achieves the goal of allowing the handle to be retracted with just one hand.

B. Unique lever Mechanism

Levers are the most basic machines that are used to complete tasks quickly and easily. A lever that amplifies an input force to produce a larger output force is called a lever. We are aware that the weights, forces, and fulcrums of various types of levers vary.

VI. PROBLEM IDENTIFICATION AND RECTIFICATION

Walkers that are sold commercially come in a wide variety of styles. These gadgets may be delivered with one, two, or four wheels. A lot of these items were made to be more user-friendly than the typical walker. These days, height-adjustable stair climbing serves as a three-in-one mobility device that helps with gait alignment, stair assistance when climbing and descending stairs, and support during walking. We discovered that the mechanisms for adjusting the height of the adjustable stair climbing walker are weak and difficult to use fast. We searched for high strength and quickly access locking mechanism and found out the **Ball lock pin mechanism.**

Fig.1 Quick return Ball lock pin

VII. METHODOLOGY

It has been proposed to design a high strength and quick access height adjustable walker product for the purpose of walking on the surface, slope and climbing up and down of stairs without the help of others. It can be created and tested to see if it is truly applicable. A few essential parts have been made internally using easily accessible materials. The necessary accuracy was met through careful handling throughout the procedure, and the assembled device is a flawless device that fulfills the proposal.

Fig.2 Walker

VIII. WALKER COMPONENTS

Components

- Aluminium Pipe, Ball pock pin, Cross Bar, Extension rod
- Button clip, Hand grips, Glide caps
- Anti-Rattle ring, Nuts and Bolts
-

Telescope Member

A Telescopic member having an inner cylinder fitted to slide on an outer cylinder in the axial direction. Aluminium material is used.

Fig.3 Telescopic member

Ball Lock Pin

Ball lock alignment pins have a precisely ground shank and are very strong and fast to release. Until the button is pressed to remove the positive locking, the center spindle must travel forward, allowing the locking balls to retract. Here, **Button handle ball lock pin is used.**

Ball lock pin with different handles

- L head handle
- Button handle
- Combination handle
- Safety handle
- Elastic handle
- Basic version with standard handle

Fig.4 Button handle Ball lock pin

Cross Bar

A cross bar is a horizontal bar between two upright post which gives support to them.

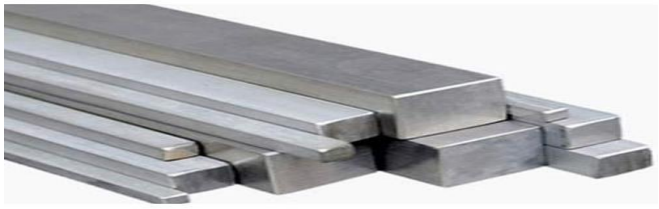

Fig.5 Cross Bar

Push Button

Push button is a switch to control a process. In order to make it easy to push or depress, the surface is often flat or contoured to fit a human finger or hand.

Fig.6 Push button

IX. PRODUCT SPECIFICATION

Dimensions

Aluminium pipe

- Length=2400 mm; Outer Diameter=25 mm

Thickness=1.585 mm

- Length=1600 mm; Outer Diameter=19 mm

Thickness=1.175 mm

Positioning Bar

- Length=590 mm; Outer Diameter=15.9 mm

Thickness=1.1 mm

H Bar

- Length=160 mm; Outer Diameter=25 mm

Thickness=1.585 mm

Cross Bar:

- Length=670 mm; Outer Diameter=15.9 mm

Thickness=1.1 mm

Rectangular Bar

- Length=540 mm; Height=25 mm

Width=10 mm

Ball lock pin:

- Length=380mm; Pin Diameter=14 mm;
- Ball Diameter= 12 mm

Fig. 7 Dimensions of walker

Working

At the top of the front leg there is a push button to adjust the height. When we press the push button, activated spring mechanism draws the balls inside the pin shaft and required height can be adjusted. The ball retracts and locks into place when the push button is released, reactivating the spring-loaded ball lock. For climbing up the stairs or slopes, either we have to reduce the height of front leg or we have to increase the height of rear leg. For climbing down the stairs or slope, either we have to increase the height of front leg or we have to decrease the height of rear leg.

Fig.8 Adjustable stair climbing walker

Model of Walker

Fig.9 Solid works model

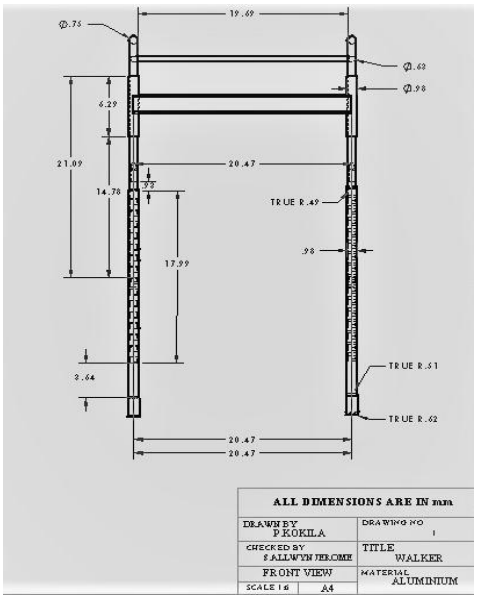

Fig.10 3DDrawing of walker (front view)

X. FEATURES

Material: Aluminium Alloy

Height Adjustable: 15 steps

Height: 80-96cm

Width: 58cm

Depth: 46cm

Load Bearing Capacity: 100kg

Frame Style: Foldable

Shape: H shape

Advantages

- Light in weight.
- It is safe and stable.
- It also used for climbing stairs.
- It is helpful for gait alignment.
- It is foldable and carried to any place
- We can walk without the help of others.
- Height adjustable mechanism has high strength.

XI. CONCLUSION

A successful walker design was created that reduces the chance of a person falling laterally. A great deal of background information was used to construct the walker design. In the unlikely event that the walker starts to tip laterally, it briefly expands the base of support and adjusts the system's center of mass to maintain the user as close to the base of support as feasible.It uses the four lateral leg extensions to do this. The upgrades took the form of adaptable additions that fit onto any typical walker. The walker design was produced and put through testing, which verified that it worked and was effective in using the two techniques to keep the user from falling. Because falling could cause an injury to oneself, it was not possible to dynamically test the lateral leg extensions. To find out how much the lateral leg extensions expand the base of support, the walker was tilted.Walker also lessens the possibility of the user falling by minimizing misuse. People using walkers when they are outside of their support base are a common cause of falls. The guidance system maintains the system's center of mass inside the support base. Therefore, elderly people who require assistance walking on flat surfaces and climbing stairs can greatly benefit from an adjustable stair climbing walker. It is reliable, easy to use, and safe.

Future Scope

- Installation of odometer to check the distance they covered during walking.
- Calorimeter to check the calories burn per day.
- Alarm Button for giving alert to the relatives, if they fall.
- Auto-Braking system while falling.

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